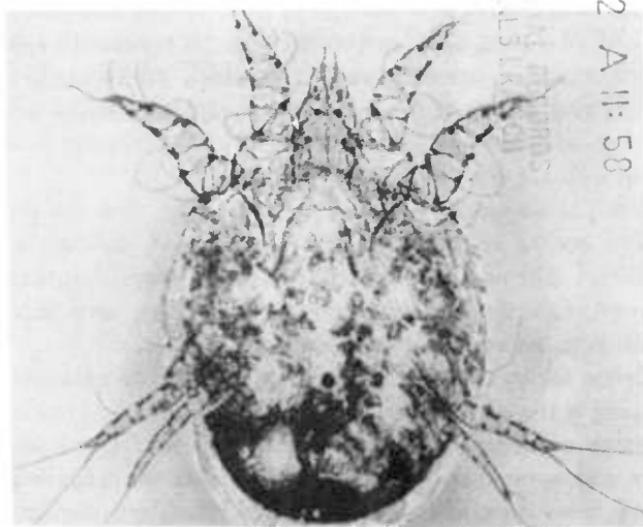


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CATTLE SCAB



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AND
**METHODS OF CONTROL
AND ERADICATION**

Farmers' Bulletin No. 1017

U. S. DEPARTMENT OF AGRICULTURE

CATTLE SCAB is a contagious skin disease affecting cattle of all classes, ages, and conditions. It is caused by minute parasitic mites, several species of which affect cattle. The nature and habits of the mites, the symptoms caused by each species, and methods of distinguishing the different kinds of cattle scab are described in this bulletin.

Scab is injurious to all classes of cattle, but the greatest injury occurs among bulls and old or weak animals of low vitality. Shrinkage in weight, unthrifty condition, arrested growth, functional disturbances, low vitality, and increased death rate, all result in serious financial loss.

Cattle scab can be eradicated by dipping or spraying, but dipping is the more reliable method of treatment. Lime-sulfur, nicotine, and crude-petroleum as dips, and BHC and lindane as dips and sprays are efficacious. Methods of preparing and using these dips and sprays are described and the intervals between treatments are given. The conditions under which the various dips and sprays may safely be used for the different kinds of scab are discussed. Also, plans of cattle-dipping plants, directions for building vats, and dipping and spraying cattle are given.

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Cattle Scab and Methods of Control and Eradication

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Varieties and General Characteristics

SCABIES IN CATTLE, commonly known as scab, mange, or itch, is a contagious skin disease caused by parasitic mites living on or in the skin. The four species of mites affecting cattle are classified zoologically in four different genera: *Psoroptes*, *Sarcoptes*, *Chorioptes*, and *Demodex*.

The mites obtain their food from the tissues of the host animal causing wounds or lesions in the skin. Each kind of mite possesses distinctive habits and, in the early stages of the disease, the lesions and their location on the animal's body are individually characteristic. *Psor-*

optic mites, which cause common scab, live in groups or colonies on the surface of the skin, producing lesions that spread in all directions from the spot first affected. Sarcoptic mites burrow into the skin, each female making a separate gallery in which she lays her eggs. Chorioptic mites live in groups on the surface of the skin but usually remain localized on the escutcheon and legs or tail with a tendency to spread slowly. Demodetic mites are much smaller than other mites, being truly microscopic in size, and appear more like worms than typical mites. They live in the hair follicles and sebaceous glands, the evident lesions consisting of small spherical swellings or pustules in the skin.

¹ Revision of former editions by Dr. Marion Imes.

Psoroptic or Common Scab

Since about 1935 the incidence of psoroptic scab has been decreasing among cattle in the United States. Its position as the most important form of cattle scab is now being replaced by chorioptic and sarcoptic scab. In the western part of the United States, especially where cattle graze on open range, the losses caused by common scab have been a serious disadvantage to the industry. Through the cooperative work of the Bureau of Animal Industry and the officials of the States concerned, the disease has become exceedingly rare though it is occasionally found on cattle in farming communities in various sections of the country. Mere control is not enough in combating scabies; it is important to eradicate the disease completely in order to prevent it from again becoming generally prevalent. It causes great losses unless properly treated.

When allowed to spread, common scab becomes a serious disease affecting cattle of all ages, classes, and conditions. It causes shrinkage in weight, failure of young stock to thrive and gain weight normally, and an increase in the death rate of poorly nourished animals of low vitality, especially range cattle exposed to inclement weather.

Causes of Common Scab

Common cattle scab is caused by small pearly-white mites known technically as *Psoroptes equi* var. *bovis* (fig. 1). The full-grown female measures about one-fortieth and the male about one-fiftieth of an inch in length. They are barely visible to the naked eye when placed on a dark background. They can easily be seen with the aid of a hand lens. The body is oval or egg-shaped and the tapering head is longer than broad. The mature

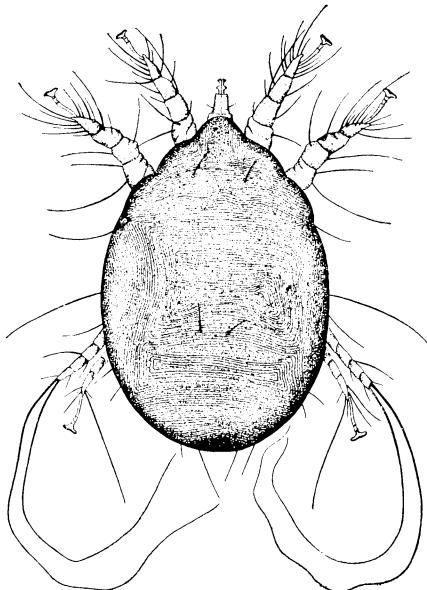


Figure 1.—Psoroptic scab mite. Female. Magnified 100 times.

mite has four pairs of legs, all of which extend beyond the margin of the body.

The entire life cycle is passed on the body of the host animal. Each female may deposit from 15 to 24 eggs, which hatch after 3 or 4 days' incubation. The young mites reach maturity, mate, and the females deposit eggs in from 10 to 12 days. These stages in the life history have an important bearing on the interval which should elapse between treatments.

Dipping, if properly done in lime-sulfur or nicotine, will kill all the mites but cannot be depended upon to destroy all the eggs. Some of the eggs will survive and hatch after the first dipping, forming a new generation of mites. To complete the treatment the new generation should be destroyed by a second dipping before they have had time to develop and deposit eggs.

The interval between the first and second dippings should be from 10

to 12 days. The eggs hatch in from 4 to 7 days and the young mites begin laying eggs when 10 to 12 days old. The interval between dippings may be extended safely to a maximum of 14 days. However, the interval of 10 to 12 days coincides more closely with various phases of the life cycle.

Symptoms of Common Scab

The mite which causes common cattle scab may attack any part of the body covered thickly with hair, the first lesions usually occurring on the withers, over the back, or around the root of the tail. From these points it spreads to other areas and, unless checked, may involve practically the entire body.

The scab mite pricks the skin to obtain food and in so doing, causes a slight inflammation, but this early stage of the disease is rarely detected. As the mites multiply, large numbers of small wounds are made in the skin and are followed by intense itching, formation of papules, inflammation, and exudation of serum. The serum which oozes to the surface becomes mixed with dirt and more or less infected with micro-organisms. This mass soon hardens into yellowish or gray-colored scabs which frequently are stained with blood. In the early stages the scab may be about the size of a pea, but as the mites seek the healthy skin around the edges of the wound, it gradually increases in size.

Some of the mites migrate to other parts of the body and start new lesions, which extend until they cover large areas (fig. 2). As the disease advances, increasingly large areas become denuded of hair and covered with thick, adherent crusts or scabs. The skin becomes tumefied, corrugated, and greatly thickened (fig. 3). The itching is severe

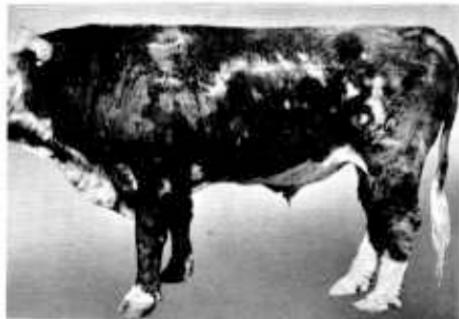


Figure 2.—A well-developed case of common scab. A steer cannot thrive while suffering from this disease.

and the animal is constantly irritated. In its efforts to relieve the itching and irritation the animal spends so much time licking, rubbing, and scratching that it has very little time for grazing. Consequently it loses flesh, becomes weak and emaciated, and unless relieved finally dies.

Detecting Scab in Early Stages

The diagnosis depends upon finding the mite which causes the disease. To find it, scrape the outer edges of the infected areas with a blunt-edged knife, transfer the scrapings to a smooth, black surface, such as a piece of black paper. Spreading the scrapings in the warm sun or near artificial heat usually causes the mites to become active and they can be seen as minute, gray bodies moving against the dark background. They are plainly visible under a low-power hand lens. By parting the hair of infected animals and removing the small scabs, the mites can sometimes be seen on the underlying moist, red skin and removed upon the point of a knife blade for examination. When the mites are causing active irritation, and the surface of the skin around the edges of the lesion or under the small scabs is red and moist, the parasites are usually present in



Figure 3.—A case of common scab, showing characteristic wrinkles on neck and shoulder.

large numbers. If the lesions and surrounding skin are dry and dull in appearance, the mites are probably inactive and will be difficult to find.

Persistent licking, rubbing, or scratching is the first indication of scabies, lousiness,² and similar conditions. Remember that scabies is caused only by scab mites. The hair conceals the small scabs in the early stages of the disease; its disarranged condition indicates the area to be closely examined. By manipulating such areas with the hand the dried serum or scabs may be found, removed for examination, and a search made for mites. The areas of skin affected by scab become thickened and hardened. This condition may be detected readily by pinching up a portion and comparing it with the surrounding healthy skin. Other conditions re-

sembling scab rarely if ever cause this characteristic, uniform thickening of the skin.

Well-advanced cases of scab are easy to diagnose, but the disease should never be allowed to reach this stage. In the early stages it yields readily to proper treatment, but if allowed to spread it entails heavy losses.

Contagiousness of Common Scab

It is generally believed that each species of domesticated animal has its own peculiar variety of psoroptic scab, and that it is not transmissible to other species of animals. However, when sheep and cattle are confined together, the disease may pass from one kind of animal to the other.

The common scab mite of sheep has been artificially transferred to a few individual cattle, producing typical psoroptic scabies lesions on these animals. After having lived for several months on cattle, the infestation was readily passed back to sheep.

The disease is transmitted by direct contact with animals or objects that are carriers of the mites. It spreads much more rapidly among closely confined cattle than among those on the open range or in large pastures. The disease develops much more rapidly and is more severe in its effects on old, weak, or poorly nourished animals. Nevertheless, feed-lot animals in full vigor often become infested to such extent that they do not thrive or gain weight normally even when full fed. Bulls, old cows, and unthrifty cattle are usually the first to contract the disease, and during the winter the contagion spreads rapidly to other cattle in the herd. Visible lesions of scab may develop 15 to 45 days after exposure, or it may be much longer.

² See Farmers' Bulletin 909, "Cattle Lice and How to Eradicate Them."

One infested animal can transmit the disease to a herd during any season of the year, although cattle in a thriving condition on green, succulent feed seldom contract scab. In fact, in the spring, when infested cattle are turned out on green grass and the old coat of hair is shed, symptoms of the disease may disappear. However, it will break out again the following winter. The infestation is carried over from year to year, on cattle, not in the barn.

One or more attacks of the disease do not confer immunity, and after cattle have been treated and cured, they may become reinfested by contact with infested animals. Under laboratory conditions where temperature, humidity, and other factors can be controlled, cattle scabies mites can be kept alive for 2 to 3 weeks and their eggs retain vitality during that time. In barns and corrals, mites and their eggs dropping off the animals survive for only a very few days under the most favorable conditions. They are quickly destroyed by bright sunlight and excessive dryness. They do not propagate except on the animal's body, so the contamination of barns, pens, or corrals is a rather remote possibility. However, mites and their eggs can be mechanically transmitted by blankets, brushes, and curry combs. Thoroughly clean and disinfect such equipment before using it on clean animals.

Treatment of Common Scab

The only rational treatment for scabies consists in using some external application which will kill the parasites without injuring the animals. Internal remedies, such as sulfur and salt and various other preparations, have not proved effective and should not be used. Common cattle scab is easily cured if proper treatment is applied before the disease becomes advanced.

The dips commonly used and permitted by the Bureau of Animal Industry for use in official dippings of cattle for scabies are lime-sulfur and nicotine solutions. Two dippings, from 10 to 12 days apart, in one of these dips can usually be depended upon to cure common scab.

Spraying with benzene hexachloride (BHC) or lindane, if properly done, will also eradicate cattle scab. Two treatments from 10 to 12 days apart with a gamma isomer concentration of 0.075 percent prepared from either BHC or lindane will usually eradicate the disease.

Sarcoptic Scab

Sarcoptic scab, known in some regions as barn itch, is found on both farm and range cattle throughout the country. It is a winter health hazard causing serious economic losses in both dairy and beef herds. It is particularly serious in dairy herds of the Midwest and Eastern States. Numerous reports from other sections of the country indicate that the disease is becoming more troublesome each year and that it is much more widespread in the United States than is generally realized, being spread by the sale and exchange of cattle. Purebred bulls of the beef breeds seem to be especially susceptible to the disease and are often responsible for its spread. Infested cattle may not show visible lesions or symptoms at the time they are shipped. Later, when the disease is discovered, it has already been transmitted to members of the new herd.

Sarcoptic scab has been considered more serious than common or psoroptic scab because of the greater difficulty in eradicating it with lime-sulfur, nicotine, and crude petroleum dips. However, when BHC or lindane is used, it is no more difficult to cure than any other type.

When introduced into a herd the infestation may persist for years and cause serious losses unless proper methods of treatment and sanitation are adopted. The losses are caused by irritation, unthrifty condition, arrested growth, decreased vitality, functional disturbances, and an increased death rate. When dairy cattle are affected there is a loss in the milk supply. With effective treatment, marked improvement in milk production follows. When the breeder of pure-bred cattle who supplies bulls for grading-up range and farm herds finds sarcoptic scabies in his herd, his business is very nearly ruined until the disease can be eradicated.

Sarcoptic Scab Mite

The parasite which causes sarcoptic scab is known technically as *Sarcoptes scabiei bovis* (fig. 4) and resembles in a general way the common scab mite. It is slightly

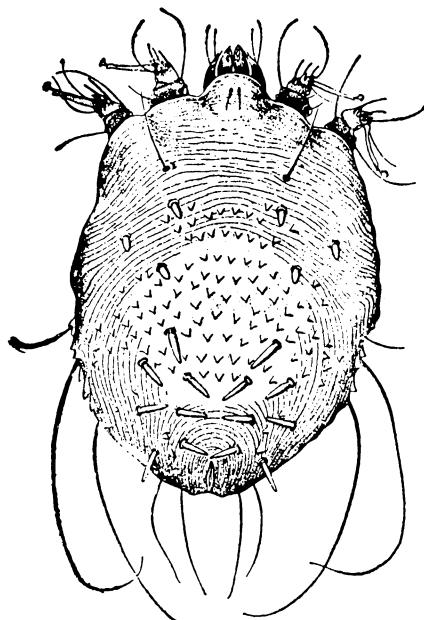


Figure 4.—Sarcoptic scab mite. Female. Magnified 100 times.

smaller than the latter, the mature female measuring about one-fiftieth and the male about one-sixtieth of an inch in length. The body is more nearly round than oval and the bluntly rounded head is as broad as it is long. When mature this mite has four pairs of short, thick legs, the fourth pair and usually the third pair not extending beyond the margin of the body. A conspicuous feature under a high-power microscope is a number of short, backward-projecting spines on the upper surface of the body.

As in the case of the common scab mite, the entire life cycle of the sarcoptic mite is passed on the body of the host animal. The sarcoptic mite, however, does not remain on the surface but penetrates through the upper layer of the skin and excavates burrows, or galleries, in which the sexes mate and the eggs are laid. Each female may lay from 10 to 25 eggs during the egg-laying period, which probably lasts from 12 to 15 days. When the egg-laying period is completed the female dies in her burrow. When the young mites hatch out, in from 3 to 10 days, they are close to the surface of the skin, which is constantly wearing away and being renewed from beneath. They can escape easily from their shallow burrows, and it is probable that at least a part of their life, before egg laying begins, is spent on or near the surface. The young mites pass through several molts before reaching maturity. Then they form new burrows and the cycle commences again.

The average period of incubation on the animal is about 4 days and the average period after hatching until egg laying begins is about 11 days. Therefore, a new generation of mature mites may be produced by each fertile female in about 15 days. The commonly used dips will not always penetrate to the bottom

of all burrows and kill all the mites at one application. Therefore, the interval between dippings cannot be calculated as accurately for sarcoptic mites as for psoroptic mites. When two or more dippings are given, the interval between dippings should be from 6 to 10 days.

If the animals are sprayed with BHC or lindane, the interval between treatments should be from 10 to 12 days.

Symptoms of Sarcoptic Scab

Sarcoptic scab mites, in establishing themselves on cattle, prefer locations where the hair is thin and the skin is tender. The first lesions are frequently found on the escutcheon or on the inner surfaces of the thighs (fig. 5), as is also the case with chorioptic scab (fig. 6). From these regions they spread to the inside of the flanks. As the disease progresses the mites spread forward along the abdomen to the brisket; and posteriorly over the outer surface of the legs, upward to the root of the tail and downward on the legs. If the disease is not checked, they may cover the entire surface of the body. The affected areas show



Figure 5.—A case of sarcoptic scab, showing characteristic appearance of skin on inside of hind legs and escutcheon.



Figure 6.—Cow with chorioptic scab.

a loss of hair and the skin becomes covered with heavy crusts or scabs. In very extensive and chronic cases the involved skin becomes greatly thickened, wrinkled, and takes on a typical elephant-skin appearance. The wrinkles are usually thickly inhabited by mites. Scrapings from the bottom of a fold will usually contain them in abundance. In severe cases the animals lose flesh, become emaciated and greatly weakened, and unless properly treated many of them die, especially under unfavorable weather conditions.

Sarcoptic scab varies in its intensity from one herd to another, with slight cases and only a few animals affected in one herd, and many more in the next. The lesions on some cattle may be much more extensive and conspicuous than on others even though the infestations were contracted at the same time.

The parasites burrow into the skin, each mite making a separate gallery over which the skin becomes inflamed and swollen. The swollen areas are somewhat larger than pin-

heads and often a yellowish granule of dried serum adheres to them. As the mites multiply, the diseased area increases and the granular, conical papillae, or raised areas, come closer together. The hair over the affected part stands erect and some of it drops out or is rubbed off, though usually a few scattered hairs remain even in advanced cases. When the mites are inactive, the skin takes on a dry, scurfy, or leather-like appearance.

To relieve the intense itching, the animals lick, scratch, and rub the affected parts until the skin becomes raw. The mechanical injury results in a running together of the small lesions, and large scabs are formed. When the disease reaches this stage it resembles common scab and can be differentiated only by identifying the mite. In the early stage, typical sarcoptic scab can be distinguished from other types by the location of the lesions and the manner of spreading. Most of the lesions disappear during the summer, but on careful examination, small lesions may still be found around the base of the tail or on the underside of the abdomen.

For practical purposes in the field, where facilities for examination are limited, the principal differences in form and structure of the two species of mites may be summarized thus: The sarcoptic mite is slightly smaller than the psoroptic mite, and its body is more nearly round than oval; the psoroptic mite is egg-shaped or oval. Adults of both species have four pairs of legs, those of the psoroptic mite being long and all four pairs extending beyond the margin of the body. The legs of the sarcoptic mite are shorter and heavier and the two hind pairs do not extend beyond the margin of the body. The head of the psoroptic scab mite is sharply pointed and cone shaped and longer

than broad, while that of the sarcoptic mite is bluntly rounded in front and is as broad as long.

The burrowing habits of the sarcoptic mite make it difficult to find, especially in the early stages of the disease. When skin scrapings are made to find them, and skin must be scraped until the blood oozes from the tissues.

Contagiousness of Sarcoptic Scab

Sarcoptic scab is transmissible from one species of animal to another and also from animals to man. When mites are transferred from one species of animal to another, they live for only a limited time, because they are not perfectly adapted to conditions on their new host. Sarcoptic mites of the horse, sheep, and cat have been known to live on cattle, but infestations produced by them do not persist because the mites usually die after a relatively short time. Mites found on the horse, dog, hog, and cattle have been known to be transmitted to man causing great discomfort and annoyance for a short time. Persons milking infested dairy cows frequently acquire sarcoptic mange through prolonged contact. However, man is not a natural host, and when the infestation is eradicated from the cattle, the infestation on the milkers has a tendency to eliminate itself.

Sarcoptic cattle scab is contagious to all classes of cattle and is commonly transmitted by direct contact. Although the disease apparently spreads more slowly than common scab, it makes great headway in herds during the winter when cattle are confined in yards and stables and come in frequent contact with one another. In range herds the bulls and old cows are the most susceptible. It spreads among the herd much more rapidly during

the fall and winter than at other times of the year. During the winter, the lesions spread rapidly, and the entire surface of the animals' bodies may become involved. The activity of the mites is reduced with the advent of spring, and during the following summer the lesions on many animals may disappear. Yet enough mites survive to become active again in the fall and winter.

While the disease is almost entirely spread by direct contact with infested animals, the mites can be transferred mechanically by curry combs, brushes, and blankets. However, the mites can propagate only on the animal's body. If they are dislodged and fall to the ground they die in a short time. Normally, also, the eggs hatch only on the body of the animal. Exposure to sunlight and dryness is particularly detrimental to both the mites and the eggs. Under laboratory conditions mites have lived for as long as 3 weeks off the animal; in barns and pens this period is much less. It is remotely possible for cattle to contract the disease from contaminated pens or stables, but this is not the common method of spread. However, cleanliness and sanitation should not be neglected, because such practices definitely contribute to the health and general welfare of all classes of livestock.

When sarcoptic scab exists in a herd the owner should make a determined effort to prevent the transfer of live mites from one animal to another. Infested animals should be isolated, if possible, and all curry-combs, brushes, and blankets used on such animals should be thoroughly disinfected before they are used on clean animals.

Treatment of Sarcoptic Scab

Sarcoptic mites, because of their burrowing habits, are much more difficult to eradicate than common

scab mites. The dips recommended for common scab will kill sarcoptic mites if the liquid comes in contact with them, but these dips may not reach all the mites at one application. Persistent, thorough, and frequent application of the common dips, however, will effect a cure, especially if all infested parts are scrubbed well with a brush and soaked with dipping solution just prior to the first dipping.

Four dippings in either lime-sulfur or nicotine dip will cure sarcoptic scab in cattle. The interval between dippings should be from 6 to 10 days. When properly used these dips are not injurious, and cattle may be dipped in them any number of times without losses other than those caused by shrinkage and accidents.

One dipping in crude petroleum usually cures sarcoptic scab, as it seems to destroy the eggs as well as the mites. One of the greatest drawbacks to the use of crude petroleum as a dip is that in some cases it is injurious to the animals. Spraying with lindane or BHC will eradicate sarcoptic scab if the animals are thoroughly sprayed. A gamma isomer concentration of 0.075 percent should eradicate the infestation if the cattle are sprayed twice 10 to 12 days apart. Better results will be obtained if the animals are treated inside the barn, confined in stanchions or stalls. Use approximately 4 to 5 gallons of spray per animal.

Chorioptic Scab

The incidence of chorioptic scab in cattle has been rapidly increasing for several years. In the United States it has virtually displaced psoroptic, or the common type of the disease. Psoroptic scab is now rarely encountered in the United States as a result of the systematic eradication measures carried on by

the Bureau of Animal Industry in cooperation with livestock sanitary officials of the various States. On the other hand, chorioptic scab has increased, particularly in the Mid-western States and some of the Northeastern States. In some of these States the incidence of chorioptic scab is about three to four times that of sarcoptic scab. It is not unusual to find a combination of chorioptic and sarcoptic scab in the same herd and not infrequently they exist on the same animal.

The widespread increase of chorioptic scab has made this disease a very important economic factor in successful livestock farming and dairying. When it becomes established in a herd, it may last for years unless attempts are made to eradicate it. Persistent cases of chorioptic scab in a herd of cattle result in serious economic losses due to constant irritation, unthriftiness, and reduced vitality. The constant irritation has a most unfavorable effect on milk production of dairy cattle. Infested beef cattle do not make rapid gains. The value of diseased purebred herds raised and sold for breed improvement is sharply reduced and can be restored only by eradication of the disease.

Chorioptic Scab Mite

The chorioptic scabies mite is known scientifically as *Chorioptes bovis* var. *bovis* (fig. 7). It resembles closely the psoroptic scab mite but is slightly smaller. It is slightly larger than the sarcoptic mite. The body is ovoid, a trifle longer than wide. The front pair of legs is longer than those of the sarcoptic mite. These mites are more active and travel much faster than the sarcoptic mites. This characteristic is of assistance in distinguishing the two species. They have rather short and blunt mouth parts while the psoroptic scab mite



Figure 7.—Foot scab mite of cattle, *Chorioptes bovis* var. *bovis*. Magnified 90 times.

has much sharper mouth parts. As seen under the microscope, the psoroptic mite has a long, jointed stalk on the end of the front legs; the chorioptic mite a short, unjointed stalk, and the sarcoptic mite a long, angularly set, unjointed stalk. The mites causing chorioptic scabies live in colonies on the surface of the skin. They are equipped with penetrating mouth parts that enable them to pierce the skin to obtain serum and lymph upon which they live. Chorioptic scab mites do not usually produce such severe and conspicuous lesions as do either the psoroptic or sarcoptic mites. Furthermore, they do not spread as rapidly over the animal's body as do the psoroptic mites. After they have pierced the skin a very small papule or pimple is formed. As the mites multiply, the papules merge with other adjoining ones and gradually build up a sizable involved area on the skin. Each papule exudes a small quantity of serum, which dries and leaves a thin crust. Under the crust the skin may be raw and inflamed. As the disease progresses, the skin becomes thickened and wrinkled, has a roughened, corrugated appearance, is largely devoid of hair, and is covered with a thin dried crust. (Fig. 6.)

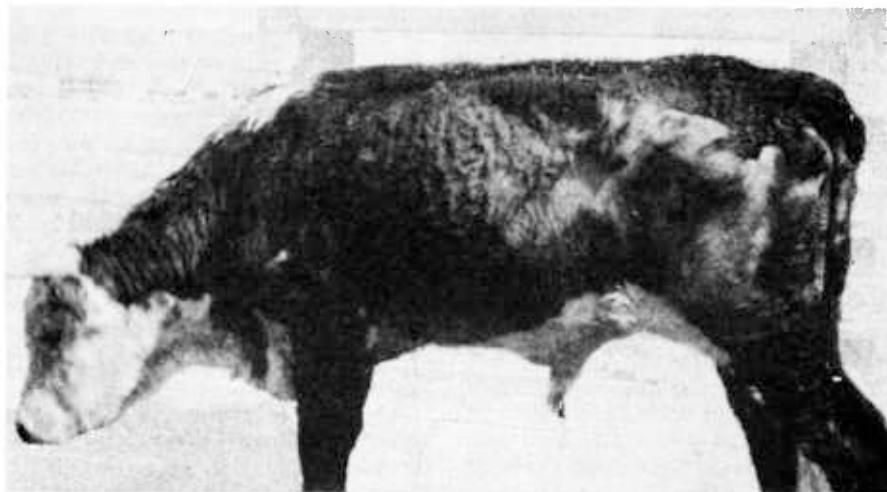


Figure 8.—Steer with chorioptic scabies.

The lesions of chorioptic scab are most commonly found on the escutcheon (fig. 6). From this region they may spread upward to the base of the tail or downward to the inside of the thighs and forward to the flanks. In the more advanced cases lesions extend to both the inside and outside of the hocks. Lesions, however, may be found almost anywhere on the body (fig. 8). They are less frequent on the front legs, but may also appear above the knees and on the breast.

Chorioptic mites cause considerable itching though apparently it is not so severe as that produced by either psoroptic or sarcoptic mites. Infested animals lick and bite themselves, scratch themselves with their hind feet, and rub against fence posts, trees, or other cattle. When animals are confined to stanchions, they sway back and forth, rub against adjoining cattle, stamp their feet, switch their tails in the absence of flies, and strike their bodies with the hind feet. They commonly rub their necks on the stanchions. All this activity causes considerable noise when they are

confined in steel stanchions, especially those fastened by chains at the top and bottom. This disturbance is so noticeable during the winter that dairymen now recognize it as the usual accompaniment of extensive scabies infestations.

The lesions develop more rapidly in the winter, especially when the cattle are stabled, and it is during this period that animals suffer most. As the weather warms up in the spring, the lesions gradually recede. During the hot part of the summer, especially when the cattle are out in the open, the disease virtually disappears. An occasional case of scabies will remain active throughout the summer but this is exceptional. However, the disease returns on the same animals in the fall and develops again throughout the winter.

Contagiousness of Chorioptic Scab

The disease is transmitted almost entirely from animal to animal by contact. Close confinement in barns and sheds in the winter offers the

best conditions for spreading the disease to other members of the herd. It appears to spread as rapidly as sarcoptic scab. Chorioptic mites are wanderers and as the mite population increases, they may at times be found anywhere on the body. The infestation can also be spread by means of curry combs, brushes, and blankets. Under favorable conditions in a laboratory environment the mites can live as long as 3 weeks off of the animal's body. It is remotely possible for the animals to contract the disease through contact with barn litter or fence posts and other objects where infested animals have been rubbing themselves. After the animals have been treated, disinfect all equipment used on the animals and burn old litter.

Treatment of Chorioptic Scab

Like other forms of scab, chorioptic scab should be treated either by proper dipping or thorough spraying of all the animals in the herd. When lime-sulfur, nicotine, and crude petroleum dips are properly used, they can usually be relied upon to eradicate scab from the herd. The disease can also be treated with sprays, the more effective being BHC and lindane.

Demodectic (Follicular) Mange

Until about 1923 demodectic (follicular) mange in cattle was not often reported in the United States. But the damage to leather caused by demodectic lesions was so great that interest was stimulated, and during 1927 numerous cases from 14 States were reported by inspectors of the Bureau of Animal Industry. Most of the cases were in old cows of the dairy breeds.

The lesions of demodectic mange in cattle appear as nodules, most often in the skin of the neck, shoulders, breast, dewlap, and sometimes other parts. The size of the nodules varies from that of a small pinhead to that of a hazelnut or even larger. Except in advanced cases there are no marked changes in the hair coat, and ordinarily the lesions are not visible until the hair is parted. The nodules, however, can be detected by passing the hand over the body with the fingers pressed firmly against the skin.

The nodules are usually firm, and in advanced cases several may unite to form a small abscess. When these larger lesions rupture and discharge their contents over the surrounding hair and skin, the condition resembles common scab. Ordinarily the nodules contain a creamy white material of cheesy consistency. Usually it is necessary to lance the nodule to obtain material for examination.

Positive diagnosis can be made by finding the mite, *Demodex folliculorum bovis*, which causes the disease. The small wormlike mites are easily found by pressing between two glass slides a small quantity of the contents of one or more nodules and examining it under a low-power microscope.

Demodectic mange may progress rapidly until the nodules appear nearly everywhere in the skin, or there may be little or no alteration in the number and size of the nodules during a period of several years. Although the disease does not spread rapidly to other members of the herd, infested animals should be isolated to prevent its possible spread. There is no known practicable remedy for demodectic mange in cattle, although frequent dippings delay its progress and may cure mild cases.

Methods of Treatment

Dipping and spraying are the two methods of treatment commonly used for cattle scab. Dipping is the only method recognized by the Bureau of Animal Industry in the official treatment of scabby cattle. It is the most practical and effective method known. In the dipping vat the entire surface of the animal's body receives a thorough wetting. Dipping plants are usually arranged so that cattle enter one end of a vat, swim through the dip and leave the vat at the opposite end (fig. 9).

Spraying

In areas where dipping vats are not available, the livestock grower is obliged to use some method other than dipping to treat his cattle for scab. Spraying as a possible substitute for dipping is being prac-

ticed in many parts of the United States. With the development of efficient equipment and the production of water-dispersible and emulsifiable insecticides, spraying is becoming increasingly popular. (Fig. 10.)

Spraying is not so effective as dipping, because of the difficulty of thoroughly wetting the hair and skin of cattle with a spray. Much of the dip runs off and is wasted. Unless plenty is used and spraying is continued until all parts are well soaked, the treatment is not effective. Cattle scab can be cured by spraying, however, if the work is done properly. Any of the dips recommended for scab may be applied in the form of a spray, and the interval between sprayings should be the same as that between dippings—that is, 10 to 12 days.

All animals in the herd should be treated, regardless of the number showing lesions of scab. One treatment, however, generally is sufficient for cattle not visibly diseased; in other words, it is sufficient for cattle that have been exposed, but among which the disease has not yet become apparent.

The principal advantage of spraying is that the equipment can be moved from farm to farm or wherever the cattle may be. Treatment can be conducted inside barns as well as outside in pens or chutes. Its greatest disadvantage is that thorough wetting of the animals is not always accomplished. Successful treatment of cattle scab depends upon complete and thorough wetting of all affected animals. Thorough wetting of an animal having a winter coat of hair requires from 4 to 5 gallons of spray, but less is required in summer when the hair is short.

When cattle are sprayed in stanchions, each animal can be given individual attention, and if the oper-



Figure 9.—Dipping cattle in concrete vat.



Figure 10.—A small, power-driven sprayer, with angle nozzle which facilitates thorough cleaning and disinfecting of equipment.

ator takes sufficient time to go over the animal's body the treatment will be very effective. When cattle are sprayed in a pen or a chute, they must not be overcrowded. When too many cattle are handled at one time, they crowd up together and only a part of the body is exposed to the spray. In a pen, they must have sufficient room to turn around. They will turn their heads away from the spray and, unless they can be turned around or moved, only a part of the body will be properly sprayed. Particular attention should be paid to wetting the head, face, brisket, underside, and between the thighs. The underside can be properly sprayed if an extension of pipe, having 2 or 3 nozzles at a 45° angle, is attached to the barrel of the spray gun.

All power sprayers should be equipped with an agitator to keep the insecticide in the tank in suspension. The motor should be of such size as to develop and maintain a pressure of 200 to 400 pounds per square inch. Sprayers should be equipped with two hoses because two operators can handle the cattle much more efficiently than one. Much time and material are lost when only one operator is working. The guns should be equipped with quick release valves having an adjustable device that will permit a change of spray pattern to correspond to the distance from which the animals must be sprayed.

The treatment of cattle scab by spraying is still in an experimental stage. The recommendations given are tentative until more data are

collected. Cattle scab has been successfully treated with BHC and lindane when the animals were treated twice at intervals of from 10 to 12 days. Only the wettable powder form of the insecticide has been used. The active insecticidal agent in lindane and BHC is the gamma isomer. The concentration of the spray mixture must be based upon its gamma isomer content. For cattle scab it is suggested that a concentration of 0.075 percent of gamma isomer be used. Spray the animals twice at intervals of 10 to 12 days using 4 to 5 gallons of spray per head.

Lindane is usually obtained in wettable powder form containing 25 percent gamma isomer. BHC can be purchased containing 6, 10, or 12 percent gamma isomer. The following chart gives the quantities of wettable powder to use for 100 gallons of water to make a spray having a gamma isomer concentration of 0.075 percent.

Gamma isomer in product :	Pounds per 100 gallons
6 percent-----	10½
10 percent-----	6½
12 percent-----	5½
25 percent-----	2½

Small quantities of BHC are absorbed through the skin and deposited in the tissues of treated animals. It is partially eliminated through the milk; therefore, producing dairy cattle should not be treated with BHC. Beef cattle to be slaughtered for human consumption should not be treated within 30 days of the date of slaughtering. In disposing of excess quantities of spray do not allow it to collect in pools from which the animals may drink. It should not be allowed to contaminate feed or the grass where they might graze. Do not pollute streams or ponds with excess spray because BHC is poisonous to fish.

Dipping

If dipping is to be successful it is necessary to give close attention to details and see that the work is performed carefully and thoroughly. Water and feed the cattle, so they will not be hungry or thirsty at the time of dipping. If they are watered and fed from 2 to 4 hours before dipping, they are likely to be in the best condition for the operation. If the cattle have been driven and are hot at the time of reaching the vat, they should be allowed to cool off before being dipped. It is dangerous to dip them while they are overheated. When the nights are cold, dipping should be finished for the day early enough for the animals to become dry before sunset.

The dip in the vat should be maintained at a depth of 70 or 80 inches, or a depth sufficient to swim the tallest animal. First ascertain the quantity of dip that is going to be required. The average 1,000-pound, short haired steer will carry out and retain about 2 quarts of dip. Long-haired animals of the same weight will retain about 1 gallon. If none is lost by leakage or otherwise wasted, the quantity of dip required will be the amount the animals carry out and retain, plus that required to charge the vat.

The capacity of the vat is usually calculated in the following manner: Multiply the average length in inches by the average width in inches, then the product by the depth in inches; this will give the approximate number of cubic inches of space to be filled with dip. Divide this by 231 (the number of cubic inches in a gallon), and the result will be approximately the number of gallons of dip required to charge the vat. To obtain the average length add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled), and divide the sum by 2.

Obtain the average width in the same manner. The depth should be taken at the middle of the vat, and should be from bottom to dip line only and not to the top of the vat. To determine the length and width, measure only the space to be filled with liquid and not above that line. The capacities of the various tanks are obtained by a like process. Gages or rods should be prepared and marked to show the number of gallons at various depths in the vat and tanks.

After the vat is filled to the required depth, stir the contents well, so that the dip will be of uniform strength and temperature. A good method is to fasten a rope to a bucket, allow the vessel to fill and partially sink, then drag it rapidly from one end of the vat to the other, repeating the operation several times. Stirring plungers (fig. 11) are useful implements and are easily made. One or more should be provided at every vat. Their use is similar to that of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat.

Before beginning operations, examine the pens, chutes, slide board, vat, etc., for projecting nails, broken boards, or any object that may puncture or wound the cattle. The dip may injure those having fresh wounds. The animals should be handled as carefully as possible, although very little control can be exercised in dipping wild range cattle. Range cattle, not accustomed to being handled, are easier to dip than tame farm animals, as they go through the chutes and enter the vat more readily. If animals start running through the chute, restrain them to prevent their piling up and drowning in the vat. At large dipping plants a gate is usu-

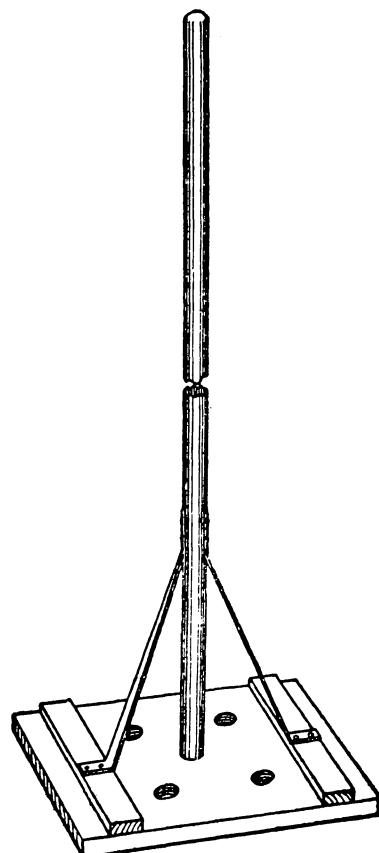


Figure 11.—Stirring plunger for mixing liquids in the vat.

ally built in the chute near the entrance to the vat so that the animals in the chute may be held back and allowed to pass only as room is made for them. If the chute has no gate, a bar slipped across between the side boards will answer the purpose. Gentle farm animals, and especially old milk cows, usually do not enter the vat readily—in fact it is often necessary to push them on the slide board.

When cattle are dipped in lime-sulfur, nicotine, or crude petroleum, the hard crusts and scabs should be broken with a stiff brush and well soaked with dip solution before they go into the vat. Visibly affected

cattle should be held in the vat 2 or 3 minutes and their heads submerged at least once for an instant. Assistance should be rendered promptly if they appear to be strangling. Men with dipping forks should be stationed along the vat to duck the heads of the animals and to keep their bodies submerged. This may be done by placing the dipping fork over the withers and pushing the animal under. Dipping forks (fig. 12) may be bought ready-made or may be made by a blacksmith.

After the cattle leave the vat, hold them in the draining pens until all surplus dip has drained from their bodies. Change the dip as soon as it becomes filthy regardless of the

number of animals that have been dipped. When cleaning the vat, remove the entire contents, including all sediment and foreign matter.

Dips

In selecting a dip for cattle scab, consider the conditions under which it is to be used. If the dipping plant is supplied with soft water any of the dips recommended for scab may be used, but if the water is very hard the dip that mixes best with the water available should be selected. Hard water may be softened with sal soda or lye, but no more should be added than is necessary. From 1 to 4 pounds of sal soda to each 100 gallons of water is usually sufficient. Lime-sulfur dip mixes well and may be used in hard water without injury to animals but it is more effective in soft water. Nicotine dips are suitable for use in any reasonably good water. It is possible to cure scab with coal-tar-creosote dips if they are used in soft water. They sometimes injure animals, and may fail to cure the disease when used in hard water. BHC and lindane dips can be used in either soft or hard water. The addition of small quantities of one of the common household detergents will increase their effectiveness, particularly if the water used is hard.

Dips deteriorate through use; after a number of animals have passed through the vat the active principle of the dip falls below the standard required to destroy mites. Under certain conditions some of the dips may be injurious. Consequently the Department of Agriculture does not give permission for the use of any dip in the official dipping of cattle for scabies unless it has been shown to the satisfaction of the Bureau of Animal Industry (1) that the strength of the dip when diluted ready for use may be determined satisfactorily in the field

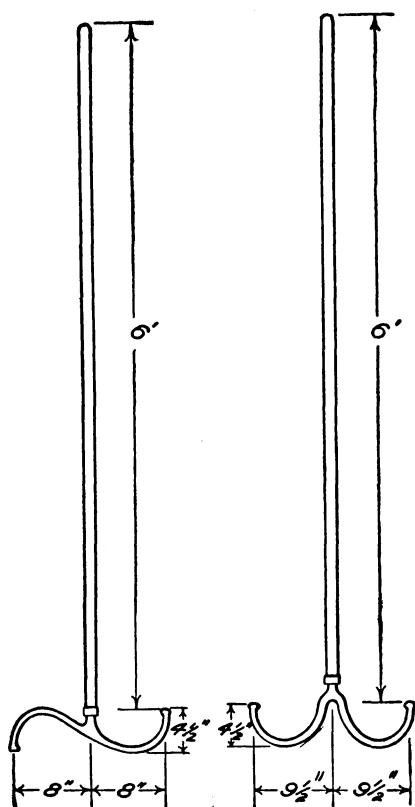


Figure 12.—Two styles of cattle-dipping forks.

by the use of a practical, portable testing outfit; (2) that under actual field conditions the dipping of cattle in a solution of definite strength will eradicate scabies effectually without injuring the animals. At present the only cattle-scabies dips that fulfill these requirements are lime-sulfur and nicotine.

Lime-Sulfur Dip

In dipping cattle for scabies, the lime-sulfur dip should be used warm. The temperature of the dip while the animals are in it should be maintained at from 95° to 105° F.

Lime-sulfur dip is made in the proportion of 12 pounds of unslaked lime (or 16 pounds of commercial hydrated lime) and 24 pounds of flowers of sulfur or sulfur flour to 100 gallons of water. Weigh the lime and sulfur and measure the water; do not trust to guesswork. Slake the lime in a shallow, watertight box or tank and add water enough to form a thin paste. Sift the sulfur into the paste and mix well with a broad hoe until a mixture of about the consistency of mortar is formed, adding water as required. Put the mixture into 30 gallons of boiling water, adding it slowly so as not to interrupt the boiling, and boil until the sulfur disappears from the surface. The boiling should be continued from 1½ to 2 hours without cessation, and the mixture stirred to prevent settling and caking on the bottom. When the sulfur has disappeared from the surface and the mixture is of a chocolate or dark-amber color, discontinue the boiling.

Draw off or dip out the contents of the boiling tank, place them in the settling tank, and let them stand until all solids have settled to the bottom and the liquid is clear. Some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so ar-

ranged that it may be used for both boiling and settling. An ordinary watertight barrel will serve very well for a settling tank at a small vat. A settling tank of any kind should have an outlet at least 4 inches from the bottom in order that the clear liquid may be drawn off without becoming mixed with any of the sediment. (See fig. 13.)

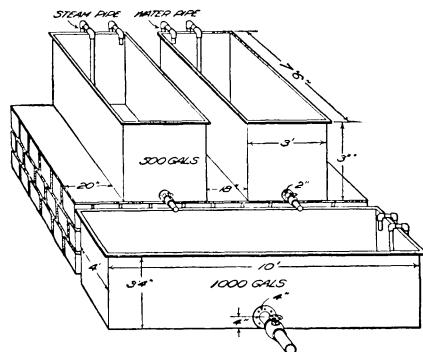


Figure 13.—Cooking and settling tanks.

Drawing off the liquid through a bunghole is better than dipping it out, because dipping stirs the liquid and mixes it with the sediment. The prime object is to get the clear liquid without any sediment; any sediment may injure the animals.

When fully settled draw off the liquid into the dipping vat and add warm water enough to make a total of 100 gallons. When mixed and cooked as specified above the concentrate is $3\frac{1}{3}$ times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-sulfur dip in large quantities several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity, a large enough quantity of the dip should

be cooked at one time to dip the herd. The quantity of mixture in the cooking tank may be varied, but not the proportions of the ingredients.

Proprietary brands of lime-sulfur dip may be purchased, and many of them are equal to or even better than homemade dips. Ready-prepared dips should be diluted and used in accordance with instructions on the container.

Nicotine Dips

Nicotine dips are sold under various trade names. Farmers and livestock growers are more or less familiar with them as dips for animals and as insecticides for insect pests of plants. To be effective against cattle scab, nicotine dips should contain not less than 0.05 percent nicotine. If much stronger than that they may injure cattle, especially if the animals are dipped while hot. If properly used and maintained at proper strength they cause no injury. A field test has been designed by a dip manufacturer by which the percent of nicotine in the dip can be determined at any time. Nicotine dips should be used in accordance with the instructions on the container. Do not use any preparation the strength of which is not given on the label.

Nicotine dips are used warm, but should not be heated above 105° F. During dipping operations for scab the temperature of the nicotine dip should be maintained at from 95° to 100°.

Sulfur is sometimes added to nicotine dips in the proportion of 16 pounds of flowers of sulfur to 100 gallons of diluted dip. Very little of the sulfur is dissolved in the dip. Most of it remains in suspension during dipping, and is deposited on the skin of the animal, where it re-

mains for a long time with beneficial effect. Two dippings will cure chorioptic and common scab.

Crude-Petroleum Dips

The crude-oil dips are not commonly used for either chorioptic or common cattle scab, but have proved effective in treating cattle for sarcoptic scab. One of the greatest drawbacks to their use is that the oil is liable to injure animals, especially if they are moved rapidly too soon after treatment, or are exposed to bright sunshine, or become chilled.

Unprocessed crude petroleum is the most effective crude-oil dip. However, processed crude petroleum (residue from the manufacture of gasoline and other light hydrocarbons) is commonly used as a cattle dip and is effective in eradicating sarcoptic scab. There are also on the market several proprietary brands of crude-petroleum dips, consisting of processed crude oil to which other ingredients have been added.

In dipping cattle in crude-petroleum dip, fill the vat with water to within 1 foot or 18 inches of the dip line and then add the oil until the surface of the dip is flush with the dip line. The oil floats on the water, forming a layer from 12 to 18 inches deep, depending on the quantity added, and as the animals pass through the vat their bodies become coated with oil. The oil dips are used cold and one dipping usually is sufficient to cure sarcoptic scab.

When cattle are dipped in any of the crude-petroleum dips, a cool shady place should be provided near the dipping vat where they may be quiet and protected from the sun for several days. If this is impossible the oil dips should not be used.

Benzene Hexachloride (BHC) and Lindane Dips

Chlorinated hydrocarbon insecticides have been used as dips for cattle to only a limited extent. However, as BHC and lindane are effective as sprays, it is reasonable to assume that a dip containing a concentration of 0.06 percent gamma isomer, prepared from either wettable BHC or lindane, may prove effective for the eradication of scabies from a herd of cattle. Two dippings are suggested at an interval of 10 to 12 days, and the cattle should be held in the vat for at least 1 minute to assure complete wetting of the skin and hair.

Two styles of dipping plants are shown in the plans (figs. 15 and 16). Either is suitable for dipping cattle or horses for any purpose. The chutes, draining pens, etc., shown in one set of plans, may be substituted for those shown in the other. Another type, octagonal in shape, has also given satisfactory results and is especially adapted for dipping large herds. Information concerning this vat appears in the 1932 Yearbook of the U. S. Department of Agriculture.

In selecting a location for a dipping plant, remember that animals work better upgrade. The corrals and running chute should slope up

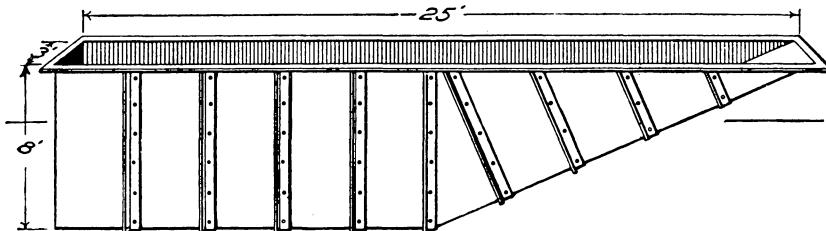


Figure 14.—Portable galvanized-metal dipping vat.

Dipping Plants

The farmer who has a small number of animals to dip may use a portable galvanized-metal vat (fig. 14). These vats may be purchased ready-made, and answer the purpose very well for dipping small lots of light- or medium-weight cattle. After digging a trench and setting the vat with the top flush with the surface of the ground, provide a chute and a slide board as a means of getting the animals into the vat.

A permanent dipping plant is much more satisfactory, and when a number of farmers in a community wish to dip their cattle a good plan is for them to contribute in proportion to the number of cattle owned and use the fund in building a community dipping plant.

to the entrance end of the vat. The vat should be on level ground, preferably extending north and south, with the entrance at the south and the exit at the north. Animals work better when not facing the sun. A considerable quantity of water is required, so the dipping plant should be close to an adequate supply. The vat, however, should not be built on low, marshy land or where flood waters overflow.

Corrals and Chutes

The set of receiving corrals, as well as the set of holding corrals, into which animals go from the draining pens, should each be large enough to hold the largest herd to be dipped. They should be constructed so that there may be the least possible number of corners in

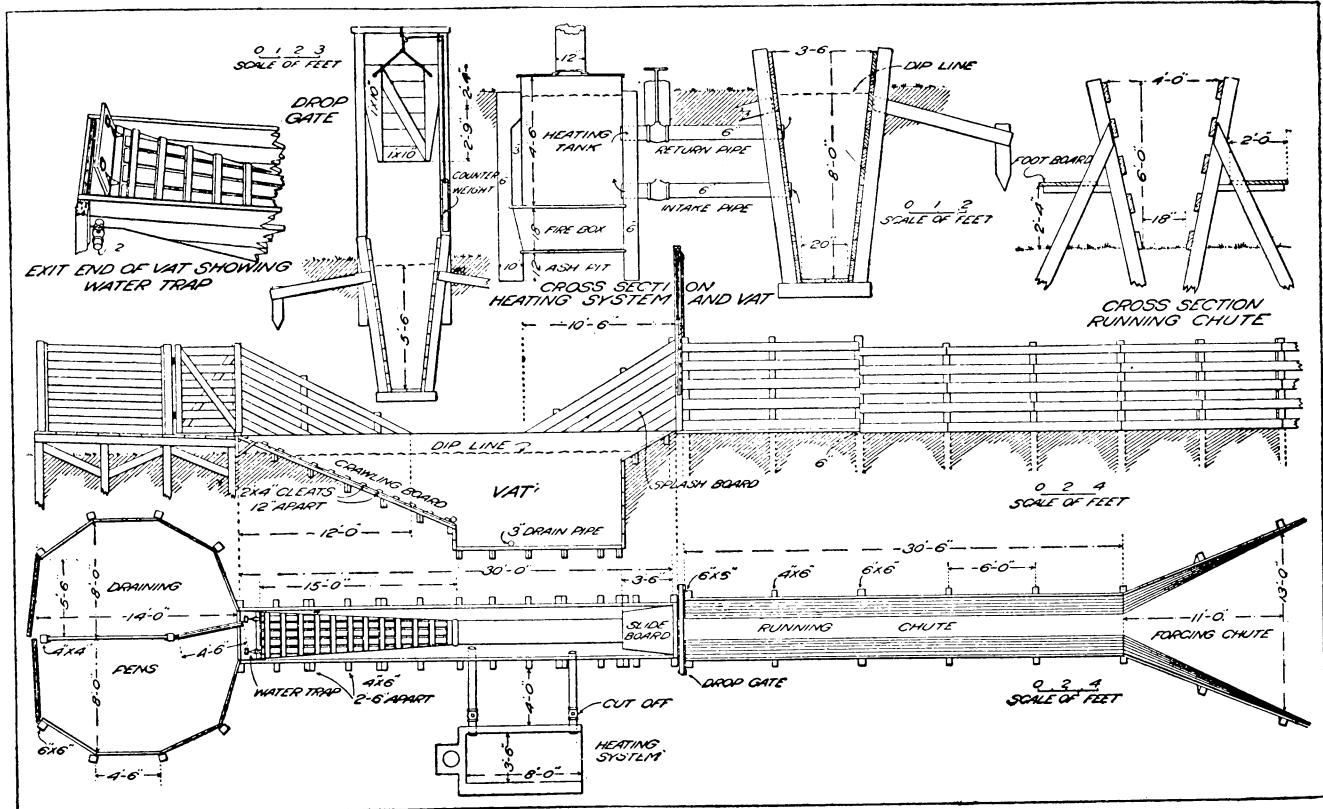


Figure 15.—Plan of cattle-dipping plant with wooden vat.

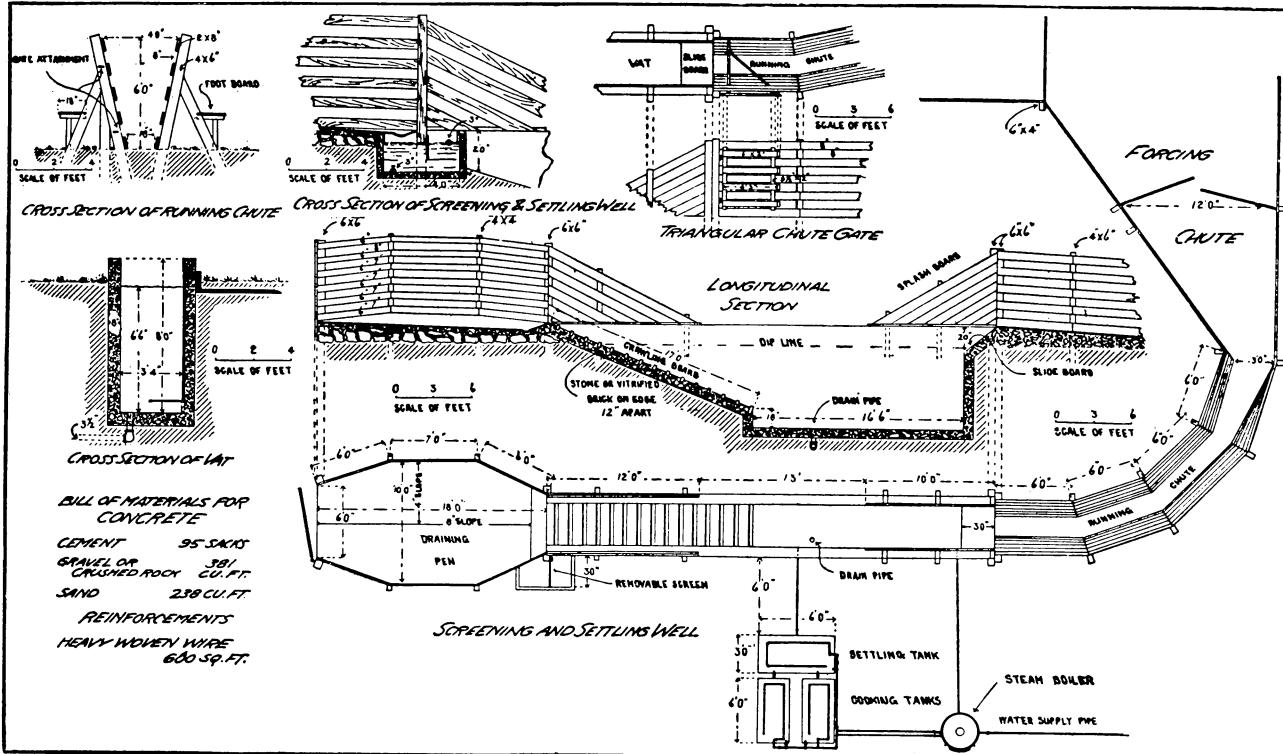


Figure 16.—Plan of cattle-dipping plant with concrete vat.

which the cattle may become crowded and injured.

Improperly constructed chutes add greatly to the difficulty of getting cattle into the vat and often cause rough handling of the animals. The running chute should be at least 30 feet long and preferably curved to prevent the approaching animals from seeing the vat. Two styles of running chutes and crowding chutes are shown in the plans, and dimensions and structural details are given. Two styles of chute gates also are shown. Most stockmen probably prefer the triangular gate. Figure 15 shows a drop gate that may be adapted for use either as a check gate in the chute or as a holding gate in the vat. A holding gate in the vat at the beginning of the exit incline should be provided in order that visibly affected animals may be held in the dip the required length of time.

Draining Pens

When cattle emerge from the vat they carry out some of the dip, which runs off their bodies rapidly. Save this dip and return it to the vat. It may be used over and over again. Also, if allowed to drip off in the holding corrals, it will collect in pools, from which the animals may drink with possible injurious results. In any case, such mudholes are highly objectionable. Draining pens should have watertight floors sloping toward the vat or draining wells to catch and return the dip to the vat. The pens may be large or small according to the length of the vat. Their floors, of either lumber or concrete, should have settling wells or water traps to prevent rain from running into the vat and diluting the dip. A design of a settling well is shown in connection with the concrete vat (fig. 16) and one of a water trap with the wooden vat (fig. 15). The settling well may

be used with the wooden vat, in which case the water trap would be unnecessary, as the settling well serves the same purpose.

When the draining pens are constructed of concrete, the outer walls should be built like the foundations for a house, except that they should be 8 inches thick. Fill the space inside the walls with gravel to the required height and lay the sloping floors on tamped gravel. Roughen the floors with a stiff broom while the concrete is soft, or apply a coat of pebble dash to prevent slipping. If wooden floors are used they should be double, with a layer of tar paper between. Rough lumber may be used for the lower floor but the top one should be of matched boards 1 inch thick. Cleats should be nailed on the floor to prevent the cattle from slipping.

Vats

The dipping vat may be of either concrete or lumber. A concrete vat is more durable and in many other ways more satisfactory than a wooden vat. The sides may be perpendicular, as shown in the plans for a concrete vat (fig. 16), or sloping as shown in those for a wooden vat (fig. 15). Sloping sides for either concrete or wooden vats are generally considered more desirable than perpendicular ones. Both styles, however, are shown in the drawings, because some stockmen prefer vats with perpendicular sides. The dimensions shown in the cross section of the wooden vat may be followed in constructing a concrete vat with sloping sides.

The length of the vat may vary from 24 to 100 feet, depending on the number of cattle to be dipped. The top may extend from 9 to 18 inches above the surface of the ground or may be flush with it. A vat extending above the surface of the ground affords better conditions

for handling the cattle than one flush with the ground. If the top of the vat is built flush with the ground, it should extend 5 inches above the natural surface, then graded up with gravel or cinders to provide a dry path along each side.

The slide board should be made of, or covered with, a smooth-surfaced material, such as planed lumber or sheet metal. A piece of boiler plate makes an excellent slide board. The dimensions of the slide board shown in connection with the concrete vat are those commonly used. A short, steep slide board causes the animals to plunge abruptly into the dip, while a long, gradual slope allows them to slide in more gently. The short, steep slope has the advantage that the animals cannot brace themselves on it for a leap so easily as on the long, gradual slide. The exit incline or crawling board should be about 16 feet long, so that the incline may not be too steep.

Permanent pipes for conducting water and dip to the vat should be laid so as not to act as obstacles to the men working along the vat. They should enter the vat above the dip line so that any leakage may be detected. There should be no obstruction in the path along either side of the vat. There should be no crosspieces over the top of the vat that may interfere with the proper handling of cattle in the dip.

The wooden vat shown has sloping sides, but they may be perpendicular. If soft wood frame timbers are used, they should be 6 by 6 inches, but if hard wood is used 4 by 4 inch timbers are sufficiently large for the purpose. Cedar posts make good framing timbers, as they do not rot rapidly. Matched planks 2 inches thick should be used in building the vat, and they should be beveled so that all joints and seams may be caulked with oakum and rosin or similar material.

A water trap with hinged cover is shown in the exit incline of the wooden vat. While dipping is in progress both the cover and the valve to the drainpipe should be closed. When dipping is finished for the day, the water trap cover and drain pipe valve should be opened so that if rain falls in the draining pens it does not run into the vat and dilute the dip.

When homemade lime-sulfur dip is used, cooking tanks (fig. 13) are necessary. The cooking may be done in open boilers above a fire box, or live steam may be piped into them. It is also necessary to provide some means of heating the dip in the vat. Two systems of heating the dip in the vat are shown in figures 15 and 16. Settling wells are not necessary when the open-tank heating system, shown in the plans of a wooden vat, is used. The heating tank answers the purpose of a settling well. The open-tank heating system has an advantage over the old-style coil heater in that it is easy to keep the pipes from clogging.

The heating system shown in connection with the plans for a concrete vat is the one commonly used. When steam is used, the boiler should have a capacity of at least 25 horsepower. The steam pipes should extend along the floor of the vat at least two-thirds of the length and be provided with openings for the escape of steam into the dip. A check valve should be placed in the steam line to prevent dip from the vat from flowing into the boiler when the pressure is low. The condensation of the steam passing into the vat dilutes the dip to a slight extent. An allowance for this dilution should be made in replenishing the dip.

The trench for the vat should be excavated so that the inside dimensions correspond to the outside di-

mensions of the completed vat. If the sides of the trench are reasonably firm they may be used for the outer walls of the form, but in all cases in which the vat is extended above the surface of the ground it is necessary to build forms extending from the ground surface to the top of the vat. If the soil is sandy or the walls cave in it will be necessary to use outer forms, in which case the trench should be wide enough for them.

The forms are usually made of 1-inch boards and 2- by 4-inch braces. A supply of 2-inch lumber is necessary for the corrals and chutes; some of it may be used first for the forms and afterwards for constructing corrals and chutes. Two methods of bracing the forms are illustrated (figs. 17 and 18).

Bolts for fastening the slide board, the drain, and other pipes should be placed in position in the forms before the concrete is laid.

The concrete side and end walls may be reinforced with heavy woven wire embedded in the middle of the walls.

The concrete for dipping vats should be made of 1 part of Portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of screened gravel or crushed stone. The sand should be coarse, clean, and free from foreign matter. The crushed stone or gravel may vary in size from one-quarter to 1 inch in diameter. The mixing should be done on a smooth, tight platform and the sand and rock measured separately in a bottomless box 2 feet long, 2 feet wide, and 1 foot deep, having a capacity of 4 cubic feet. Mark the inside of the box $7\frac{1}{2}$ inches from the bottom, indicating $2\frac{1}{2}$ cubic feet. Each sack of Portland cement is considered equal to 1 cubic foot. Mix the sand and cement thoroughly, add the crushed stone (previously drenched

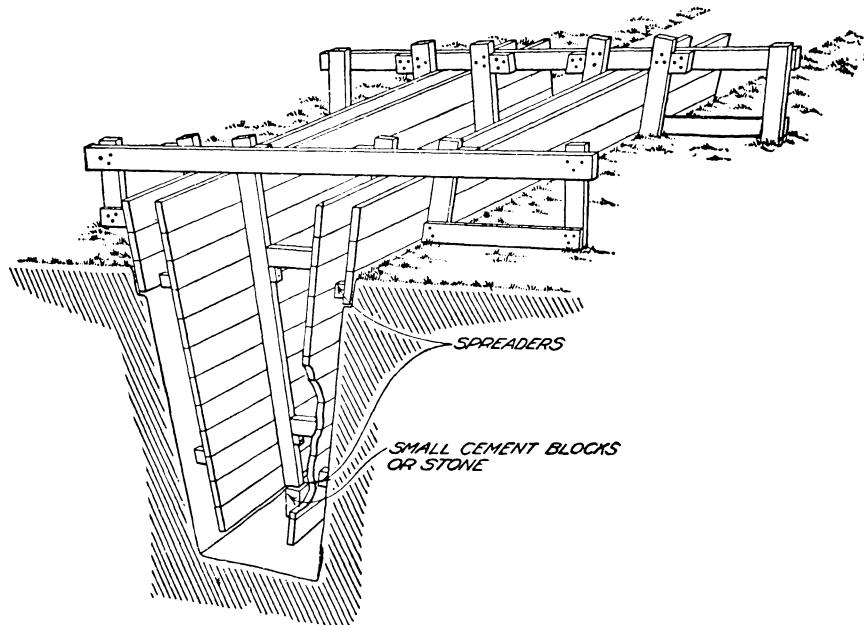


Figure 17.—Section of trench for concrete vat with sloping sides, showing the forms in place and one method of bracing.

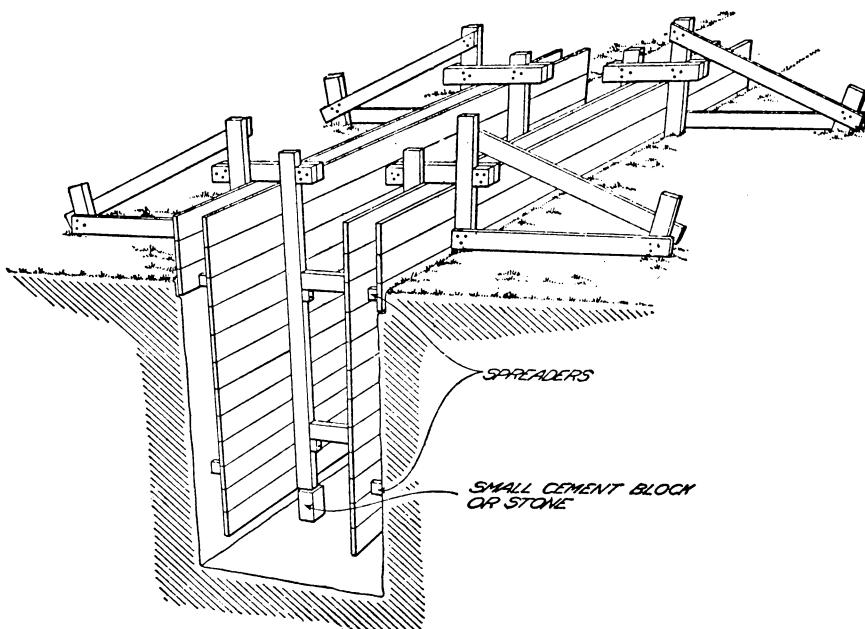


Figure 18.—Section of trench for concrete vat with perpendicular sides, showing forms in place and another method of bracing.

with water), and mix the whole mass by turning it several times with shovels. Then add water in a depression made in the center of the pile and mix well by turning several times with shovels, adding water enough during the mixing to make a quaky, or thin, jellylike mixture.

Place the concrete in the forms as soon as the mixing is finished. The floor and exit end should be laid first and the concrete well tamped. In filling the forms, the concrete should be well settled into place by spading rather than by tamping, and special attention should be given to spading next to the inside forms to force the coarse particles back and allow the sand-cement mortar to form a dense, watertight surface. An old hoe straightened

out makes a good spading tool, as the handle is long enough to reach the bottom of the forms. If it is necessary to stop work for the day before the forms are filled, the surface of the concrete in the forms should be roughened with a stick. Just before placing additional concrete, wash the roughened surface and paint it with cement and water mixed to the consistency of thick cream. Leave the forms in place 2 or 3 days, if possible, and wet the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part of cement and 2 parts of sand, or mix cement and water to the consistency of cream and apply it, brushing well to form a smooth surface.